

REMARKS

Claims 1-14 and 32-41 are pending. Claims 1, 5, 9, 12, 13, 32, and 41 are in independent form. Claims 15-31 have been canceled pursuant to their withdrawal from consideration, without disclaimer, and subject to applicant's right to pursue the subject matter of the canceled claims in a divisional application.

In the action mailed December 13, 2006, claims 5, 12, and 34-38 were allowed, and claims 39 and 42 were recognized as reciting allowable subject matter. Applicant acknowledges the recognition of allowable subject matter with appreciation. Notwithstanding this recognition, claim 12 has been amended to recite that solder layer contacts "the ~~bump~~ diffusion barrier," as shown in FIG. 6. Claim 12 is believed to remain allowable notwithstanding this amendment.

New claim 41 recites that an aluminum layer is between an adhesion layer and a seed layer of a base layer, and is thus believed to be allowable on the same grounds as claims 5, 12, 39, and 42.

Claim 13 was rejected under 35 U.S.C. § 112, first paragraph. The rejection contends that the application fails to provide a written description of a base layer metal "[contacting] the diffusion barrier to physically isolate the bump from the solder layer."

Applicant respectfully disagrees. Attention is respectfully directed to FIG. 6., which shows a base layer metal 630 contacting the diffusion barrier layer 625. Moreover, claim 13 as filed recited that the base layer metal "contacts the diffusion barrier to physically isolate the bump from the solder layer." It is thus clear that Applicant had possession of the subject matter recited in claim 13 as of the time of filing.

Accordingly, the requirements of 35 U.S.C. § 112, first paragraph, have been met. Applicant respectfully requests that the rejection be withdrawn.

Claim 13 was also rejected under 35 U.S.C. § 112, second paragraph, as being indefinite. The rejection contends that claim 13 is confusing on the basis of the specification failing to disclose contact between a base layer metal and a diffusion barrier.

Applicant respectfully disagrees. As a threshold matter, as discussed above, FIG. 6 shows a base layer metal 630 contacting the diffusion barrier layer 625.

Moreover, there is no reason to believe that the scope of the subject matter recited in claim 13 would not be discernable to those of ordinary skill. Surely those of ordinary skill would not be confused by the recitation that a base layer metal "contacts the diffusion barrier to physically isolate the bump from the solder layer."

Accordingly, the requirements of 35 U.S.C. § 112, second paragraph, have been met. Applicant respectfully requests that the rejection be withdrawn.

CLAIM 1

Claim 1 was rejected under 35 U.S.C. § 102(e) as anticipated by U.S. Patent No. 6,689,639 to Sakuyama et al. (hereinafter "Sakuyama").

As amended, claim 1 relates to an apparatus that includes a semiconductor substrate, a first conducting layer in contact with the semiconductor substrate, the first conducting layer comprising a base layer metal comprising Cu, a diffusion barrier in contact with the first conducting layer, wherein the diffusion barrier comprises a metal alloy comprising boron and phosphorus, a wetting layer on top of the diffusion barrier and comprising one of CoB and NiP, and a bump layer on top of the wetting layer, the bump layer comprising Sn. The diffusion barrier is configured to prevent Cu and Sn from diffusing through the diffusion barrier and to prevent CuSn intermetallic formation in the apparatus.

As an anticipation rejection, the rejection 1 must be based on the contention that the subject matter recited in claim 1 is shown in Sakuyama "in as complete detail" as recited in claim 1. See, e.g., *M.P.E.P.* § 2131 (citing *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236 (Fed. Cir. 1989)).

Sakuyama fails to meet this standard. For example, claim 1 recites a wetting layer that comprises one of CoB and NiP. Sakuyama fails to describe or suggest such a wetting layer. Instead, Sakuyama describes that a gold or palladium protective layer 23 is to enhance the wettability of the solder component on a nickel layer 22. See, e.g., *Sakuyama*, col. 7, line 4-14.

Former claim 7 recited a wetting layer that comprises one of CoB and NiP. The rejection of former claim 7 contended that the addition of such a wetting layer to Sakuyama would have been obvious to one of ordinary skill in light of U.S. Patent No. 6,335,104 to Sambucetti et al. (hereinafter "*Sambucetti*"). In particular, the rejection contends that *Sambucetti*'s adhesion layer 18 comprises a NiP wetting layer.

Applicant respectfully disagrees. In this regard, *Sambucetti* makes it quite clear that it is his "first diffusion barrier layer 16" that is deposited of alloy such as NiP. See, e.g., *Sambucetti*, col. 5, line 65-col. 6, line 2. After this first diffusion barrier layer 16 is deposited, a second layer 18 is deposited on top of the diffusion barrier layer 16. See, e.g., *Sambucetti*, col. 6, line 8-11. **This second layer 18 is made from gold.** See, e.g., *Sambucetti*, col. 6, line 8-17. See

also Sambucetti, col. 7, line 22-25 (referring to "Au layer 18"). Please note that a third gold or palladium layer can also be applied atop second layer 18. See, e.g., Sambucetti, col. 6, line 65-col. 7, line 4.

Since Sambucetti's solder bump 40 is to be deposited on top of the outermost gold layer 18 (See, e.g., Sambucetti, col. 7, line 22-25), Sambucetti also fails to describe or suggest a wetting layer that comprises one of CoB and NiP. Indeed, Sambucetti uses a layer of the same constitution (i.e., gold) as used by Sakuyama. Thus, even if Sakuyama and Sambucetti were combinable (which applicant does not concede), one of ordinary skill would still not arrive at the recited subject matter.

Accordingly, claim 1 is patentable over Sakuyama, either alone or in combination with Sambucetti. Applicant therefore requests that the rejections of claims 1 and the claims dependent therefrom be withdrawn.

CLAIM 9

Claim 9 was rejected under 35 U.S.C. § 103(a) as obvious over Sakuyama and Sambucetti.

As amended, claim 9 relates to an apparatus that includes a base layer metal on a semiconductor substrate, the base layer metal comprising Cu, a bump on top of the base layer metal, the bump comprising a Cu layer, a diffusion barrier on top of the bump, wherein the diffusion barrier comprises a metal alloy

comprising boron and phosphorus, a wetting layer on top of the diffusion barrier, and a solder layer contacting the diffusion barrier, the solder layer comprising Sn. The diffusion barrier is configured to prevent the diffusion of Cu and Sn through the diffusion barrier and to prevent CuSn intermetallic formation in the apparatus.

The rejection of claim is based on the contention that Sakuyama's solder bumps 41 constitute a bump on top of a base layer metal that comprises a Cu layer, as recited in claim 9. *See Office action mailed December 13, 2006, page 7, fourth full paragraph.* The basis of this rejection is presumably Sakuyama's description that solder paste 40 can be made from copper powder. *See, e.g., Sakuyama, col. 7, line 39-43.*

However, Applicant respectfully submits that this contention leads to other inconsistencies that render the subject matter recited in claim 9 non-obvious in light of Sakuyama and Sambucetti.

For example, claim 9 has been amended to recite that a diffusion barrier is "on top of the bump." Such a diffusion barrier is shown, e.g., in FIG. 6 of the specification. Since Sakuyama's nickel layers 22 are clearly below solder bumps 41 (*see, e.g., Sakuyama, FIG. 2D*) Sakuyama's nickel layers 22 cannot reasonably be considered diffusion barriers as recited in claim 9.

As another example, claim 9 has been amended to recite that a solder layer contacts the diffusion barrier. Even if one of ordinary skill were to add Sambucetti's or another solder layer to Sakuyama, applicant respectfully submits that one of ordinary skill would not place that solder layer in contact with Sambucetti's nickel layers 22. In this regard, Sambucetti clearly intends for solder bumps 41 to be the points of contact between other solder layers and his device. There is no reason to believe that one of ordinary skill would depart from this approach. Thus, even when gold or a palladium protective layer 23 does not completely shield nickel layers 22 (such as in FIG. 9B-10D), it would not be obvious for one of ordinary skill to modify Sambucetti to place a solder layer in contact with Sambucetti's nickel layers 22.

Accordingly, claim 9 is not obvious over Sakuyama and Sambucetti. Applicant therefore requests that the rejections of claims 9 and the claims dependent therefrom be withdrawn.

CLAIM 13

Claim 13 was rejected under 35 U.S.C. § 103(a) as obvious over Sakuyama and Sambucetti.

As amended, claim 13 relates to an apparatus that includes a base layer metal on a semiconductor substrate, the base layer metal comprising Cu, a bump on top of the base layer metal, the bump comprising a Cu layer, a diffusion barrier on top of the

bump, wherein the diffusion barrier comprises a metal alloy comprising boron and phosphorus, a wetting layer on top of the diffusion barrier, and a solder layer on top of the wetting layer, the solder layer comprising Sn. The diffusion barrier is configured to prevent the diffusion of Cu and Sn through the diffusion barrier and to prevent CuSn intermetallic formation in the apparatus. The base layer metal further contacts the diffusion barrier to physically isolate the bump from the solder layer.

The rejection of claim 13 lacks even a bald contention that Sakuyama and Sambucetti describe or suggest a base layer metal that contacts a diffusion barrier. Since 35 U.S.C. § 132 and 37 C.F.R. § 1.104(2) both require that the reasons for any adverse action be stated in an Office action, the rejection is facially deficient and Applicant requests that it be withdrawn.

Moreover, claim 13 recites a solder layer that is in contact with a wetting layer. Much like the rejection of claim 9, the rejection of claim 13 is based on the contention that Sakuyama's solder bumps 41 constitute a bump on top of a base layer metal that comprises a Cu layer, as recited in claim 13. *See Office action mailed December 13, 2006, page 8, fifth full paragraph.*

Even if one of ordinary skill were to add Sambucetti's or another solder layer to Sakuyama, applicant respectfully submits that one of ordinary skill would not place that solder layer in contact with Sambucetti's gold or a palladium protective layer 23. In this regard, Sambucetti clearly intends for solder bumps 41 to be the points of contact between other solder layers and his device. There is no reason to believe that one of ordinary skill would depart from this approach. Thus, it would not be obvious for one of ordinary skill to place a solder layer in contact with Sambucetti's protective layer 23.

Finally, claim 13 has been amended to recite that the diffusion barrier is "on top of the bump." Since Sakuyama's nickel layers 22 are clearly below solder bumps 41 (see, e.g., Sakuyama, FIG. 2D) Sakuyama's nickel layers 22 cannot reasonably be considered diffusion barriers as recited in claim 12.

Accordingly, claim 13 is not obvious over Sakuyama and Sambucetti. Applicant therefore requests that the rejections of claims 13 and the claims dependent therefrom be withdrawn.

CLAIM 32

Claim 32 was rejected under 35 U.S.C. § 102(e) as anticipated by Sakuyama.

As amended, claim 32 relates to a system having a circuit board. The system comprises one or more components comprising circuitry and one or more layers on the circuit board to route at least one signal between components on the circuit board. At least one of the components on the circuit board comprises a die packing interconnect. The die packing interconnect comprises a semiconductor substrate, a first conducting layer in contact with the semiconductor substrate, the first conducting layer comprising a base layer metal, the base layer metal comprising Cu, a diffusion barrier in contact with the first conducting layer, wherein the diffusion barrier comprises a metal alloy comprising boron and phosphorus, a wetting layer on top of the diffusion barrier and comprising one of CoB and NiP, and a bump layer on top of the wetting layer, the bump layer comprising Sn. The diffusion barrier is configured to prevent Cu and Sn from diffusing through the diffusion barrier and to prevent CuSn intermetallic formation in the die packing interconnect.

Sakuyama fails to describe or suggest elements and/or limitations recited in claim 32. For example, Sakuyama fails to describe or suggest a wetting layer on top of a diffusion barrier and comprising one of CoB and NiP.

In this regard, as discussed above, Sakuyama's protective layer 23 is to be made from gold or palladium.

Moreover, even if Sakuyama were combined with Sambucetti, claim 32 would still be allowable. In this regard, as discussed above, Sambucetti's second layer 18 is made from gold, and it is this layer onto which Sambucetti's solder bump 40 is to be deposited. Sambucetti thus fails to remedy the deficiencies of Sakuyama.

Accordingly, claim 32 is patentable over Sakuyama, either alone or in combination with Sambucetti. Applicant therefore requests that the rejections of claims 32 and the claims dependent therefrom be withdrawn.

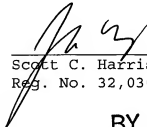
In view of the amendments and remarks herein, Applicant believes that all are in condition for allowance and asks that these claims be allowed. The foregoing comments made with respect to the positions taken by the Examiner are not to be construed as acquiescence with other positions of the Examiner that have not been explicitly contested. According, the arguments for patentability of a claim should not be construed as implying that there are not other valid reasons for patentability of that claim or other claims.

Please apply charges for the excess claims fee and any other charges or credits to deposit account 06-1050.

Respectfully submitted,

Date: March 12, 2007

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